

CLAIMS

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1. A machine for performing machining operations on a work-piece  
comprising:  
a carriage;  
a robotic arm mounted on said carriage, said arm having a movable  
head containing a tool for performing the machining operations on the work-  
piece;  
a laser position determination system for determining the actual spatial  
relationship of said carriage and said work-piece and providing a first signal  
representative thereof and further determining the spatial relationship of said  
head to the work-piece during actual machining operations on the work-piece  
and providing a second signal representative thereof;  
a computer having a computer program providing a third signal to said  
robotic arm for machining the work-piece based on a predetermined spatial  
relationship between said carriage and the work-piece and for receiving said  
first and second signals and adjusting said third signal based on the actual  
spatial relationship between said carriage and the work-piece prior to  
machining operations and said head and the work-piece during machining  
operations.

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2. The machine as set forth in claim 1 wherein said carriage is portable.

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3. The machine as set forth in claim 2 wherein said laser position  
determination system includes:

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a laser transceiver system;

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at least one first laser target mounted on said carriage;

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at least one second laser target mounted on the work-piece; and

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at least one laser target mounted on said head.

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1 9. A computer controlled machine for performing machining operations, on  
2 a work-piece, the machine having a carriage with a movable head containing a  
3 tool for performing the machining operations on the work-piece, the computer  
4 having a computer program for providing first signals to the head for controlling  
5 the movement thereof to specific spatial relationships with the work-piece so  
6 that the tool can perform the machining operations, the machine comprising:  
7 a laser position determination system for determining the actual spatial  
8 relationship of the carriage to work-piece; and to continuously determine the  
9 spatial relationship of the head during the performance of machining  
10 operations and providing a second signal indicative of the actual position; and  
11 the computer program adapted to compare said second signal to the  
12 first signal and to adjust the first signal so that the head is positioned to the  
13 specific spatial relationships.

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1 10. The machine as set forth in claim 9 wherein the carriage is portable.

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1 11. The machine as set forth in claim 10 wherein said laser position  
2 determination system includes:  
3 a laser transceiver system;  
4 at least one first laser target mounted on the machine;  
5 at least one laser target mounted on the work-piece; and  
6 at least one laser target is mounted on the head.

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1 12. The machine as set forth in claim 11 wherein said carriage includes  
2 means to lock the machine in a position in proximity to the work-piece.

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1 13. The machine as set forth in claim 9, or 10, or 11, or 12 wherein:  
2 said laser position system also determines the spatial relationship of  
3 work-piece during machining operations and provides a third signal  
4 representative thereof; and

the computer program adapted to also compare said third signal to the first signal and to adjust the first signal.

14. A method of increasing the accuracy of a machine for performing machining operations on a work-piece, the machine having a carriage with a robotic arm, the robotic arm having a head containing a tool for performing the machining operations on the work-piece, the head movable to a computed spatial relationships to the work-piece directed by a first signal from the computer based on a predetermined spatial relationship between the carriage and work-piece, the method comprising the steps of:

determining the actual spatial relationship between the carriage and work-piece prior to machining operations and providing a second signal representative thereof;

continuously determining the actual spatial relationship between the head and work-piece during the performance of machining operations and providing a third signal indicative of the actual spatial relationship therebetween; and

adjusting the first signal based on the difference between the first and signal and the second and third signals such that head remains in the computed spatial relationships to the work-piece.

15. The method as set forth in claim 14, including the step of determining the actual spatial relationship between the carriage and of the work-piece during machining operations and providing a fourth signal representative thereof; and during the step of additionally adjusting the first signal based on the difference between the first and forth signals such that the head remains in the computed spatial relationships to the work-piece continuously accomplished during machining operations.

1 16. The method as set forth in claim 15 wherein said steps of determining  
2 the actual spatial relationship between the carriage and work-piece and  
3 providing a second signal representative thereof and continuously determining  
4 the actual spatial relationship between the head and work-piece during the  
5 performance of machining operations and providing a third signal indicative of  
6 the actual position, and the step of additionally adjusting the first signal based  
7 on the difference between the first and forth signals such that the head  
8 remains in the computed spatial relationships to the work-piece continuously  
9 accomplished during machining operations are accomplished by means of a  
10 laser position determination system.

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1 17. A machine for performing machining operations on a work-piece  
2 comprising:  
3 a portable carriage;  
4 a robotic arm mounted on said carriage, said robotic arm having a head  
5 for mounting a tool for machining the work-piece;  
6 a laser position determination system comprising:  
7 at least one first laser target mounted on said work-piece;  
8 at least one second laser target mounted on said carriage;  
9 at least one third laser target mounted on said head; and  
10 a laser transceiver for determining the spatial relationship of said  
11 carriage, work-piece, and said head during machining operations,  
12 respectively, and to provide output signals representative thereof; and  
13 a computer having a first part of a computer program for machining  
14 the work-piece with said tool based on a preset spatial relationship between  
15 said carriage and the work-piece, said computer having a second part of said  
16 computer program adapted to adjust said first part of the said computer  
17 program in response to said output signals such that said head is properly  
18 positioned during the machining operations should said work-piece or said  
19 robotic arm introduce positional errors.

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1 18. A machine for performing machining operations on a work-piece  
2 comprising:  
3 a portable carriage;  
4 a robotic arm mounted on said carriage, said robotic arm having a head  
5 for mounting a tool for machining the work-piece;  
6 a laser position determination system comprising:  
7 at least one first laser target mounted on said work-piece;  
8 at least one second laser target mounted on said carriage;  
9 at least one third laser target mounted on said head; and  
10 first, second and third laser transceiver assemblies for directing  
11 laser beams at said first, second and third at least one targets  
12 respectively and to provide first, second and third signals representative  
13 of spatial relationship of said carriage, work-piece, and said head during  
14 machining operations, respectively; and  
15 a computer having a first part of a computer program for machining  
16 the work-piece with said tool based on a preset spatial relationship between  
17 said carriage and the work-piece, said computer having a second part of said  
18 computer program adapted to adjust said first part of the said computer  
19 program in response to said first, second and third signals such that said  
20 head is properly positioned during the machining operations should said  
21 work-piece or or said robotic arm introduce positional errors.

add  
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